

REMARKS

Claims 1-2, 5-15, 18-24, and 52-54 are currently pending. Claims 1, 11, 12, and 52 have been amended. Claims 55 and 56 have been canceled. No new matter is added. Reconsideration of presently pending claims 1-2, 5-15, 18-24, and 52-54 is respectfully requested in light of the above amendments and the following remarks.

Rejection under 35 U.S.C. §112, Second Paragraph, Claim 56

Claim 56 was rejected under 35 U.S.C. §112, Second Paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention.

The Examiner alleges that the limitation “the first flowing step”, “the first purging step”, “the second flowing step”, and “the second purging step” lack antecedent basis. In addition, the claim is depended on itself.

By this response, claim 56 is canceled and claim 52 are amended to recite “wherein the purging step for purging an inert gas to remove metal precursor not bonded to the substrate, the flowing step for flowing a nitrogen-containing reactant into the chamber to form one of the plurality of metal nitride monolayer, and the purging step for purging an inert gas into the chamber to remove nitrogen-containing reactant not reached with the metal precursor are performed repeatedly until a desire thickness of the composite layer is deposited.” Thus, claim 52 now includes the features of claim 56 and the steps are recited in their entirety. Therefore, Applicants respectfully request the withdrawal of the rejection to claim 56 under 35 U.S.C. §112, Second Paragraph.

Rejections under 35 U.S.C. §102(b), Claims 1, 2, 10, and 11

Claims 1, 2, 10, and 11 were rejected under 35 U.S.C. §102(a) as being allegedly anticipated by newly cited reference, Leu et al. (US Patent No. 6,605,549 hereinafter referred to as "Leu").

The PTO provides in MPEP § 2131 that

"[t]o anticipate a claim, the reference must teach every element of the claim...."

Therefore, with respect to claim 1, to sustain this rejection the Leu reference must contain all of the above claimed elements of the claim. However, contrary to the Examiner's position that all elements are disclosed in the Leu reference, the reference does not disclose, for example, "flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, wherein the metal precursor comprises at least one of $\text{Ti}(\text{OCH}(\text{CH}_3)_2)_4$ and TDEAT" and "repeating the sequence of steps (c), (d), (e), (f) until the metal nitride layer fills the opening to form a metal nitride plug."

The Examiner alleges that Leu discloses these features at column 6, lines 30-59 and in Fig. 2c, which is reproduced below:

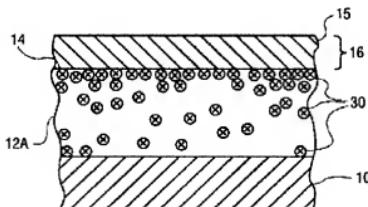


FIG. 2C

In Fig. 2c and at column 6, lines 45-50, Leu discloses that “a titanium nitride (TiN) layer 15 is formed over the treated dielectric layer 12a by alternatively depositing TDMAT and NH₃ precursors over the treated dielectric layer 12a.” Thus, Leu merely discloses that the TiN layer 15 is deposited over the dielectric layer 12a. However, Leu does not disclose that the TiN layer is repeatedly deposited until the layer fills the opening. In fact, no opening is shown in Fig. 2C. Therefore, Leu does not disclose each and every feature of claim 1.

Fig. 4e of Leu is shown below:

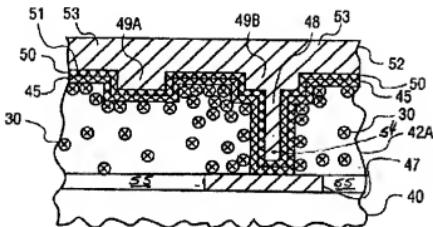


FIG. 4E

In Fig. 4e and at column 9, lines 8-12, Leu discloses that “a titanium nitride (TiN) layer 45 is formed over the treated dielectric layer 42a by alternatively depositing TDMAT and NH₃ precursors over the treated dielectric layer 42a.” “The process typically include forming a metal seed layer 50, such as a copper-seed layer 50, over the barrier layer 45 that overlies the treated ILD layer 42a and lines the inside of the trenches 49a, 49b, and via 48.” (Column 9, lines 25-28). “Following the metal seed anneal procedure, the process continues by performing electroless or electrolytic plating of substrate structure 40 to deposit a conductive material 52, e.g. metal or alloy, into trenches 49a, 49b, via 48 and overburden 53 of the substrate structure 40.”

Thus, Leu merely discloses depositing a TiN layer 45, a metal seed layer 50 over the TiN layer, and a conductive material 52 over the trenches. Leu does not disclose, for example, “repeating the sequence of steps (c), (d), (e), (f) until the metal nitride layer fills

the opening to form a metal nitride plug.” Instead, Leu fills the trenches with conductive material 52, not with a TiN layer. Therefore, Leu does not disclose each and every feature of claim 1.

In addition, Leu does not disclose, for example, “flowing a metal precursor into said ALD process chamber, said metal precursor reacts with said nitrogen containing reactant monolayer to form a metal nitride monolayer, wherein the metal precursor comprises at least one of $\text{Ti}\{\text{OCH}(\text{CH}_3)_2\}_4$ and TDEAT”. Leu merely discloses a precursor of TDMAT. Therefore, Leu also does not disclose each and every feature of claim 1.

By virtue of their dependency on claim 1, claims 2 and 5-10 are also not disclosed by Leu. Accordingly, Applicants respectfully request the withdrawal of the rejection to claims 1, 2, 5-10, and 11 under 35 U.S.C. §102(b).

Rejections Under 35 U.S.C. §103(a), Claims 12, 13, 15, and 52-54

Claims 12, 13, 15, 52-54 were rejected under 35 U.S.C. §103(a) as being allegedly unpatentable over Leu in view of Choi et al. (U.S. Patent No. 6, 815, 285 herein referred to as “Choi”). Applicants traverse this rejection on the grounds that the reference is defective in establishing a *prima facie* case of obviousness with respect to claims 12 and 52.

As the PTO recognizes in MPEP § 2142:

*... The examiner bears the initial burden of factually supporting any *prima facie* conclusion of obviousness. If the examiner does not produce a *prima facie* case, the applicant is under no obligation to submit evidence of nonobviousness...*

It is submitted that, in the present case, the Examiner has not factually supported a *prima facie* case of obviousness for the following, mutually exclusive, reasons.

1. Even When Combined, the References Do Not Teach the Claimed Subject Matter

The Leu and Choi references cannot be applied to reject claims 12 and 52 under 35 U.S.C. §103(a), which provides that:

A patent may not be obtained ... if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which the subject matter pertains ... (Emphasis added)

Thus, when evaluating a claim for determining obviousness, all limitations of the claim must be evaluated. As discussed above in arguments presented for claim 1, Leu fails to disclose “flowing a metal precursor into said ALD process chamber so that said metal precursor is deposited on said substrate, wherein said metal precursor comprises at least one of Ti{OCH(CH₃)₂}₄ and TDEAT” or “repeating the sequence of steps (c), (d), (e), (f) to deposit a plurality of metal nitride monolayers which form a composite layer that fills said opening to form a metal nitride plug.” Choi also does not disclose such features.

While Choi discloses at column 7, lines 10-13 that “an initial metal nitride layer 210 is formed on the gate insulating layer 207 and filling the NMOS and PMOS gate grooves 206 and 206a,” Choi does not disclose that the metal nitride layer is formed by “repeating (c), (d), (e), and (f) to deposit a plurality of metal nitride monolayers which form a composite layer that fills said opening to form a metal nitride plug.”

At column 7, lines 23-25, Choi merely discloses that “the initial metal nitride layer 210 may be formed from tantalum nitride (TaN), titanium nitride (TiN), and/or tungsten nitride (WN). The initial metal nitride layer 210 may be formed using a chemical vapor deposition (CVD) technique or an atomic layer deposition (ALD) technique.” There is no mention in Choi that a flowing step, a purging step, a flowing step, and a purging step are repeated to form a composite layer that fills the opening. In addition, Choi also fails to disclose a precursor of at least one of Ti{OCH(CH₃)₂}₄ and TDEAT. Therefore, Choi does not disclose the features of claims 12 and 52.

Thus, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claims 12, 13, 15, 52-54 under 35 U.S.C. §103(a) should be withdrawn.

2. The Combination of References is Improper

Assuming, arguendo, that none of the above arguments for non-obviousness apply, there is still another, mutually exclusive, and compelling reason why Leu and Choi cannot be applied to reject claims 12, 13, 15, 52-54 under 35 U.S.C. § 103(a).

§ 2142 of the MPEP also provides:

...the examiner must step backward in time and into the shoes worn by the hypothetical 'person of ordinary skill in the art' when the invention was unknown and just before it was made.....The examiner must put aside knowledge of the applicant's disclosure, refrain from using hindsight, and consider the subject matter claimed 'as a whole'.

Here, neither Leu nor Choi discloses, or even suggests, the desirability of the combination of "flowing a metal precursor into said ALD process chamber so that said metal precursor is deposited on said substrate, wherein said metal precursor comprises at least one of Ti{OCH(CH₃)₂}₄ and TDEAT" and "repeating the sequence of steps (c), (d), (e), (f) to deposit a plurality of metal nitride monolayers which form a composite layer that fills said opening to form a metal nitride plug" Neither Leu nor Choi discloses or suggests repeating the steps to form a composite layer that fills the opening. Leu merely discloses filling the opening with a conductive material. Choi merely discloses filling the opening with conventional ALD methods. There is no teaching or suggestion in either reference to repeat the steps of (c), (d), (e), (f) to deposit a plurality of metal nitride monolayers which form a composite layer that fills said opening to form a metal nitride plug." In addition, neither Leu nor Choi discloses or suggests at least one of Ti{OCH(CH₃)₂}₄ and TDEAT as a precursor. Therefore, one of ordinary skill in the art would not have been led to combine or modify the disclosure of Leu and Choi to reach the features of claims 12, 13, 15, and 52-54.

Thus, it is clear that neither reference provides any incentive or motivation supporting the desirability of the combination. Therefore, there is simply no basis in the art for combining the references to support a 35 U.S.C. § 103 rejection.

In this context, the MPEP further provides at § 2143.01:

The mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination.

In the above context, the courts have repeatedly held that obviousness cannot be established by combining the teachings of the prior art to produce the claimed invention, absent some teaching, suggestion or incentive supporting the combination.

In the present case it is clear that the Examiner's combination arises solely from hindsight based on the invention without any showing, suggestion, incentive or motivation in either reference for the combination as applied to claims 12, 13, 15, and 52-54. Therefore, for this mutually exclusive reason, the Examiner's burden of factually supporting a *prima facie* case of obviousness has clearly not been met, and the rejection to claims 12, 13, 15, and 52-54 under 35 U.S.C. §103(a) should be withdrawn.

By virtue of their dependency on claims 12 and 52, neither Leu nor Choi discloses or suggests the features of claims 14, 18-24, 53-54. Accordingly, Applicants respectfully request the withdrawal of the rejection to claims 14, 18-24, 53-54 under 35 U.S.C. §103(a).

Conclusion

It is clear from all of the foregoing that independent claims 1, 11, 12, and 52 are in condition for allowance. Dependent claims 2, 5-10, 13-15, 18-24, and 53-54 depend from and further limit independent claims 1, 12, and 52 and therefore are allowable as well.

An early formal notice of allowance of claims 1-2, 5-15, 18-24, and 52-54 is requested.

Respectfully submitted,



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Dated: January 9, 2007

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R154211

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I hereby certify that this correspondence is being filed with the U.S. Patent and Trademark Office via EFS-Web on January 9, 2007.
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